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(54) **Data storage unit.**

(57) A data storage unit comprises a housing (1), an information disc (9) which is centrically rotatable about an axis of rotation (62), an electrical drive unit (11) for driving the information disc, a bearing means (31, 32) for supporting the information disc and the rotor relative to the housing, and a scanning unit for cooperation with the information disc. The housing comprises two plane-parallel main walls (3, 4) which are oriented transversely of the axis of rotation, which each have a contour at least substantially similar to that of the information disc, and which are interconnected by smaller side walls (6, 8). The housing forms a cartridge accommodating the information disc, the electrical drive unit and the scanning unit, the information disc being disposed in a plane intersecting the electrical drive unit, and the scanning unit being situated between the information disc and one of the main walls.

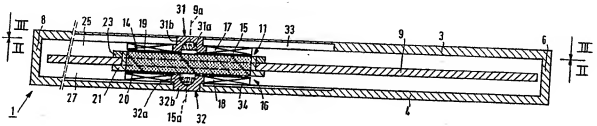

FIG.1

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The invention relates to a data storage unit comprising a housing, an information disc which is centrically rotatable about an axis of rotation, an electrical drive unit for driving the information disc, which drive unit comprises a stator and a rotor which is rotatable about a rotor axis, the rotor axis being oriented in the same direction as the axis of rotation, a bearing means for supporting the information disc and the rotor relative to the housing, and a scanning unit for cooperation with the information disc.

Such a unit is known as a magnetic recording apparatus from JP-A 55-52556 (herewith incorporated by reference). The known apparatus has a bulky housing made up of a large number of parts, whose width increases in steps viewed from the top to the bottom. The housing accommodates an electric motor having an outgoing motor shaft carrying a magnetic recording disc extending underneath the motor. The long motor shaft has two ends supported in spherical bearings. A drawback of the known apparatus is its bulkiness, which is dictated mainly by the large axial dimension of the housing, as a result of which the apparatus is not suitable for use in many modern storage systems. Moreover, the known apparatus is difficult to miniaturise.

It is an object of the invention to provide a data storage unit of the type defined in the opening paragraph but having minimal dimensions.

The data storage unit in accordance with the invention is characterised in that the housing comprises two plane-parallel main walls which are oriented transversely of said axis of rotation, which each have a contour at least substantially similar to that of the information disc, and which are interconnected by smaller side walls, the housing constituting a cartridge accommodating the information disc, the electrical drive unit and the scanning unit, the information disc being disposed in a plane intersecting the electrical drive unit, and the scanning unit being situated between the information disc and one of the main walls.

The data storage unit in accordance with the invention is a compact easy-to-handle cartridge, the limited space available in the housing being utilised to an optimum extent in a surprising manner. Preferably, the information disc extends in a plane intersecting the rotor of the drive unit. If the rotor axis coincides with the axis of rotation the information disc is preferably formed with a central opening through which the rotor of the drive unit extends, and the information disc is preferably secured to the rotor.

The size of the data storage unit in accordance with the invention is largely dictated by the diameter of the information disc accommodated in the housing. Particularly when a small information disc, for example of 1.3 inch diameter, is used the unit in the form of a cartridge can easily be secured to or in a data storage system, is easy to take along, and is easy to store.

The data storage unit in accordance with the invention is very suitable for recording data on the information disc with a high information density. Preferably, the information disc is constructed as a hard-magnetic disc on which information can be stored by means of the scanning unit, which comprises at least one magnetic head.

The data storage unit should comply with stringent requirements of mechanical accuracy, in particular as regards the manner in which the information-disc is supported. In order to enable information with an intertrack spacing of only a few micrometres to be written and/or read a highly accurate rotation of the information disc is required.

Irregular radial excursions (non-repeatable runouts) of the information disc of only a few nanometres and regular radial excursions (repeatable runouts) of the information disc of only a few nanometres are attainable with the embodiment of the unit in accordance with the invention which is characterised in that a dynamic spiral-groove bearing is arranged near each of the main walls, which bearing comprises a bearing member shaped as a segment of sphere and a bearing member shaped as a hollow segment of sphere, one of which bearing members has a groove pattern, one of the bearing members being stationary and being secured to a main wall and the other bearing member being rotatable and being connected to the rotor. In view of the desired bearing stiffness and load-bearing capacity the dynamic spiral-groove bearings are preferably of the hydrodynamic type.

Preferably, the above embodiment is also characterised in that at least one of the main walls has a compliant wall portion around the stationary bearing member, magnetic forces of the drive unit producing an axial preload on the spiral-groove bearing. This embodiment yields a tolerance-insensitive construction by the use of the high specific axial load-bearing capacity of the spherical spiral-groove bearings used in conjunction with the use of a local reduction of the flexural strength of one or both main walls in a direction parallel to the axis of rotation of the information disc. The radial bearing stiffness, which is important for the high accuracy of rotation of the information disc, depends upon the axial preload to a small extent only. A compliant wall portion can be obtained by a suitable choice of the material, for example aluminium, and the wall thickness of the main walls.

Another possibility is to provide radial grooves in a main wall around the stationary bearing section, so that this main wall becomes locally compli-

ant in a direction parallel to the axis of rotation of the information disc, the required stiffness in a direction transverse to the axis of rotation being hardly influenced. A unit in accordance with the invention thus manufactured is characterised in that the electrical drive unit is an axial-field motor, the rotor having an axially magnetised multi-pole rotor magnet and means being provided for shielding the information disc from magnetic stray flux produced by the motor. In a practical embodiment said means the means comprise an annular soft-magnetic body extending between the rotor magnet and the information disc.

An embodiment of the data storage unit in accordance with the invention is characterised in that the main walls are made of a soft-magnetic material and form part of the stator of the axial-field motor, each of the main walls, at the side facing the rotor, carrying a set of energising coils for cooperation with the rotor magnet. In this way a very high degree of integration of the drive unit, the bearing means and the housing of a soft-magnetic material is achieved, resulting in a light-weight very compact data storage unit comprising a small number of parts. The energising coils can be manufactured separately and can be secured to the main walls by means of an adhesive. The coils can also be formed directly on the main walls, for example by means of lithography techniques. The presence of said radial grooves will mitigate the occurrence of eddy currents in the soft-magnetic material of the main walls.

An embodiment is characterised in that the stationary bearing parts are surrounded by energising coils.

An embodiment is characterised in that the rotatable bearing parts are secured to the rotor magnet.

The invention will now be described in more detail, by way of example, with reference to the drawings, in which:

Figure 1 is a sectional view showing a first embodiment of the data storage unit in accordance with the invention,

Figure 2 shows the unit of Fig. 1 in a sectional view taken on the line II-II,

Figure 3 shows the unit of Fig. 1 in a sectional view taken on the line III-III,

Figure 4 is a sectional view showing a part of a second embodiment of the data storage unit in accordance with the invention, and

Figure 5 is a sectional view showing a part of a third embodiment.

The data storage unit in accordance with the invention shown in Figs. 1, 2 and 3 comprises a housing 1 having two parallel main walls 3 and 4 and four side walls 5, 6, 7 and 8 interconnecting the main walls. The walls 3 to 8 are made of a soft-magnetic material, for example aluminium or an iron-silicon alloy. The housing 1 forms an at least substantially imperforate cartridge accommodating an information disc 9 which is rotatable about an axis of rotation 9a, an electrical drive unit 11 for rotating the information disc 9, and a scanning device for scanning the information disc 9. In the present example the housing has a length of 49 mm, a width of 34 mm and a height of 3.3 mm.

The drive unit 11 is constructed as an axial-field motor comprising a rotor 14 with a permanently magnetised multi-pole rotor magnet 15 and a stator 16 with two set of coils 17 and 18, the rotor magnet preferably being a high-energy magnet, for example of NiFeB. The rotor magnet 15, which is rotatable about a rotor axis 15a which coincides with the axis of rotation 9a, is axially magnetised and opposite each of the coil systems 17 and 18 it has magnetic poles, in the present case eight. The coil systems 17 and 18, which in the present example comprise six coils each, cooperate with the rotor magnet 15 *via* an air gap 19 or 20 and are arranged on the main walls 3 and 4 respectively.

In the present example the information disc 9 is a so-called magnetic hard disc of 1.3 inch, comprising a base carrying on one side or, as in the present example, on both sides a magnetic layer in which information has been stored or can be stored. The information disc, which has a central opening through which the rotor 14, in particular the rotor magnet 15, extends, is secured to the rotor 14. For this purpose an annular soft-magnetic body 21, for example made of iron, is arranged around the rotor magnet 15, on which body the information disc 9 is centred and is secured by means of a ring 23. The soft-magnetic body 21 also shields the information disc 9 from stray flux produced by the drive unit 11.

In the present example the scanning device comprises one scanning unit 13 on each side of the information disc 9. Each scanning unit 13, which is situated in a space 25 or 27 between the information disc 9 and one of the main walls 3 or 4, comprises a magnetic head, arranged on a pivotal arm 29, for writing and/or reading information.

The data storage unit comprises bearing means for supporting the rotor 14 and the information disc 9 secured to this rotor relative to the housing 1. The bearing means comprise two hydrodynamic spiral-groove bearings 31 and 32, each comprising a bearing member 31a and 32a respectively shaped as a segment of sphere, and a bearing member 31b and 32b respectively shaped as a hollow segment of sphere. The bearing members 31a and 32a, which each have a smooth bearing surface, are secured to the rotor 14, and the bearing members 31b and 32b, which each

have a bearing surface formed with a groove pattern, are secured to the main walls 3 and 4 respectively. During rotation of the rotor 14 the groove patterns give rise to a pressure build-up in a medium, such as grease or oil, present between the bearing surfaces of the respective spiral-groove bearings.

In order to minimise tolerances the flexural strength of the bearing suspension in both main walls 3 and 4 is locally reduced. This is realised by providing the main walls 3 and 4 with a plurality of grooves 33 and 34, which extend radially from the bearings 31 and 32 respectively. The required axial preload on the bearing is provided by magnetic forces of the drive unit.

The embodiment shown in Fig. 4 bears much resemblance to the data storage unit shown in Figs. 1, 2 and 3. The unit comprises a magnetically non-conductive housing 101, for example made of aluminium, an information disc 109 which is centrically rotatable about an axis of rotation 109a, an electrical drive unit 111, two dynamic spiral-groove bearings 131 and 132, and a scanning unit, not shown, for cooperation with the information disc. The housing 101 has two plane-parallel main walls 103 and 104 oriented transversely of the axis of rotation 109a, which walls each have a contour at least similar to that of the information disc 1019. The housing 101, which takes the form of a cartridge, accommodates the information disc 109, the drive unit 111, and the scanning unit interposed between the information disc and one of the main walls. The cartridge comprises means for the mechanical and electrical connection to an external apparatus or system, such as for example a computer system. Around the bearings 131 and 132 the main walls 103 and 104 have thin wall portions 103a and 104a respectively for locally reducing the flexural strength.

In order to form a stator yoke for the drive unit 111 soft-magnetic plates 161 and 162 are provided at the location of the thin magnetically non-conductive wall portions 103a and 104a respectively.

The bearings 131 and 132 each have a bearing member 131a and 132a respectively shaped as a segment of sphere and, cooperating therewith, a bearing member 131b and 132b respectively shaped as a hollow segment of sphere. The bearing members 131b and 132b each have a pattern of grooves. The bearing members 131a and 132a, which each have a smooth bearing surface, form part of spherical bodies mounted in recesses 160 in a rotor 114 of the drive unit 111 and secured to the rotor by means of an adhesive 162.

The embodiment shown in Fig. 5, which also bears much resemblance to the unit shown in Figs. 1, 2 and 3, comprises a housing 201 of a non-magnetic material, for example a reinforced plastics, having an opening 201a in which an end plate 201b of a soft-magnetic or ferromagnetic material is mounted. The housing 201 has two parallel main walls 203 and 204 oriented transversely of an axis of rotation 209a and each carrying a respective bearing 231 or 232. The bearing 231 is secured in a thin wall portion 203a of the main wall 203 and the bearing 232 is secured in the end plate 201b mounted in the main wall 204. The housing 201 accommodates an electrical drive unit comprising a rotor with a rotor magnet 215, an information disc 209, and drive coils. The drive coils include a set of coils 118 arranged on the end plate 201b and another set of coils 117 arranged on an end plate 203b mounted against the main wall 203. The end plate 203b can be secured by means of a folded joint 205. The bearing 232 forms a comparatively stiff assembly with the end plate 201b and the main wall 204. The bearing 231, which is isolated from the end plate 203b, is secured in the housing 201 in a comparatively flexible manner owing to the thin wall portion 203a, which functions as a diaphragm. This construction enables the bearings to be mechanically preloaded in a well-defined manner. Since the end plate 203b forms a comparatively stiff assembly with the main wall 203 the axial magnetic forces on the rotor cancel one another fully or almost fully, thereby ensuring optimum bearing in operation.

It is to be noted that the invention is not limited to the embodiments shown herein. For example, in certain cases only one system of coils may be required. Moreover, several methods of securing the information disc to the rotor of the drive unit are possible.

Claims

1. A data storage unit comprising
   - a housing,
   - an information disc which is centrically rotatable about an axis of rotation,
   - an electrical drive unit for driving the information disc, which drive unit comprises a stator and a rotor which is rotatable about a rotor axis, the rotor axis being oriented in the same direction as the axis of rotation,
   - a bearing means for supporting the information disc and the rotor relative to the housing, and
   - a scanning unit for cooperation with the information disc,

   characterised in that the housing comprises two plane-parallel main walls which are oriented transversely of said axis of rotation, which each have a contour at least substantially similar to that of the information disc, and

which are interconnected by smaller side walls, the housing constituting a cartridge accommodating the information disc, the electrical drive unit and the scanning unit, the information disc being disposed in a plane intersecting the electrical drive unit, and the scanning unit being situated between the information disc and one of the main walls.

2. A unit as claimed in Claim 1, characterised in that the information disc extends in a plane intersecting the rotor of the drive unit.

3. A unit as claimed in Claim 1 or 2, characterised in that a dynamic spiral-groove bearing is arranged near each of the main walls, which bearing comprises a bearing member shaped as a segment of sphere and a bearing member shaped as a hollow segment of sphere, one of which bearing members has a groove pattern, one of the bearing members being stationary and being secured to a main wall and the other bearing member being rotatable and being connected to the rotor.

4. A unit as claimed in Claim 3, characterised in that at least one of the main walls has a compliant wall portion around the stationary bearing member, magnetic forces of the drive unit producing an axial preload on the spiral-groove bearing.

5. A unit as claimed in Claim 4, characterised in that the compliant wall portion has radially oriented grooves.

6. A unit as claimed in any one of the Claims 1 to 5, in which the rotor axis coincides with the axis of rotation, characterised in that the information disc is formed with a central opening through which the rotor of the drive unit extends, the information disc being secured to the rotor.

7. A unit as claimed in Claim 6, characterised in that the electrical drive unit is an axial-field motor, the rotor having an axially magnetised multi-pole rotor magnet and means being provided for shielding the information disc from magnetic stray flux produced by the motor.

8. A unit as claimed in Claim 7, characterised in that the means comprise an annular soft-magnetic body extending between the rotor magnet and the information disc.

9. A unit as claimed in Claim 7 or 8, characterised in that the main walls are made of a soft-magnetic material and form part of the stator of the axial-field motor, each of the main walls, at the side facing the rotor, carrying a set of energising coils for cooperation with the rotor magnet.

10. A unit as claimed in any one of the Claims 3, 4 or 5 and Claim 9, characterised in that stationary bearing parts are surrounded by energising coils.

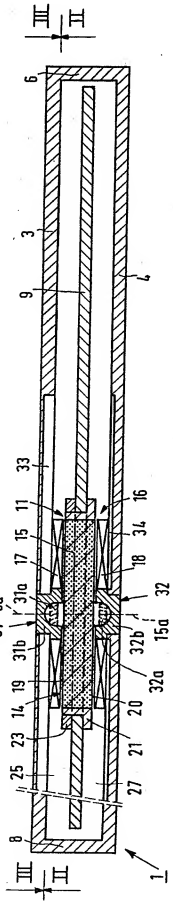
III
II
6
3
9
4
33
11
16
15
34
17
18
31a
9a
31
32
31b
32b
15a
19
32a
14
20
23
21
25
27
8
1
III
II

FIG.1

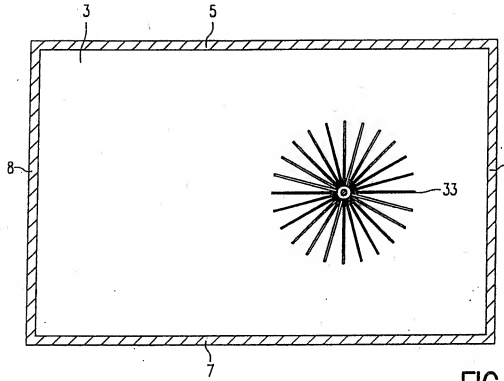

FIG.2

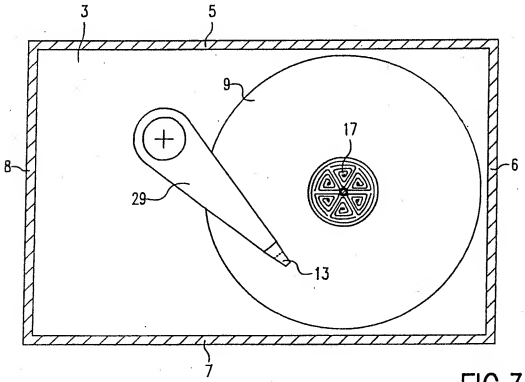

FIG.3

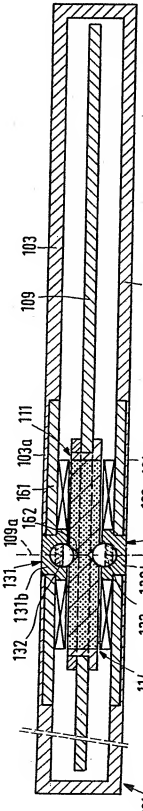
103
109
104
111
103a
104a
161
162
109a
162
132
131
131b
132b
132
132a
114
101

FIG.4

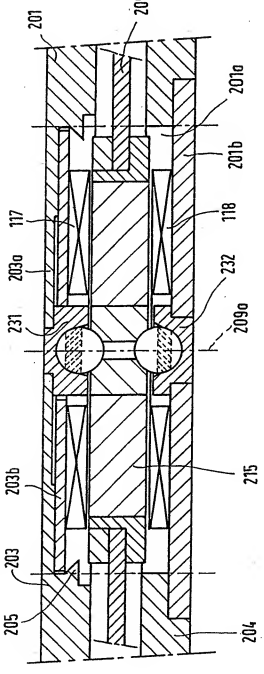
201
209
201a
201b
117
118
203a
232
231
209a
215
203b
203
205
204

FIG.5